



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/695,959	10/27/2003	Matthew W. Miller	MI22-2400	8008
21567	7590	11/02/2005	EXAMINER	
WELLS ST. JOHN P.S. 601 W. FIRST AVENUE, SUITE 1300 SPOKANE, WA 99201			TRINH, HOA B	
			ART UNIT	PAPER NUMBER
			2814	

DATE MAILED: 11/02/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/695,959

Applicant(s)

MILLER ET AL.

Examiner

Vikki H. Trinh

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 August 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-54 and 97-100 is/are pending in the application.
- 4a) Of the above claim(s) 99 and 100 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-26, 32-51, 97 and 98 is/are rejected.
- 7) ☒ Claim(s) 27-31, 52-54 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Species I, figures 1-3, claims 1-54, and newly added claims 97-98, in the reply filed on 08/17/05 is acknowledged.
2. Claims 55-96 have been canceled which direct to the non-elected species by the amendment filed on 08/17/05. Claims 1-54 and 97-100 are pending.
3. Claims 99 and 100 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected species. Note: claims 99 and 100 include a limitation of the canceled claim 55, a non-elected species, which recites the first electrode has an exposed surface that is being treated.

Claim Objections

4. Claims 12-13, 15 and 34, 43 are objected to because of the following informalities: In claims 12, 15 and 34, the term "any layer deposited by treating" is vague. The examiner assumes in this Office Action that any layer is the dielectric layer. Also, in claims 12, 15, 34, the phrase "no more than 3 monolayers thick" is ambiguous because it is not clear whether applicants intend to state that the treated layer includes 3 monolayers, or that the treated layer has a thickness of any dimension. The examiner assumes in this Office Action that applicants intend to state the treated layer has a thickness with no specific dimension. In claim 13, lines 1-2, applicants do not clearly recite the claimed subject matter because by stating that no layer is treated when in fact in claim 1 applicants recites that the dielectric layer is treated is confusing. As to claim 43, line 1, "no layer" is confusing. The examiner assumes in this Office Action that

Art Unit: 2814

applicants intend to state that the electrode layers are not treated. Appropriate correction is required.

5. Claims 27 and 52 are objected to because of the following informalities: In claim 27 and claim 52, "a borane or a silane" should be "the borane or the silane". Appropriate correction is required.

6. Claims 97 and 98 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Note that claim 97 recites the limitation of claim 12. Also note that claim 98 recites the same limitation already occurs in claim 34.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. Claims 1-4, 9-14, 19-25, 32-33, and 97 are rejected under 35 U.S.C. 102(e) as being anticipated by Merchant et al. (6,784,478) (hereinafter Merchant).

Merchant discloses, as to claim 1, a method of forming a capacitor 14 (fig. 1), comprising forming a first capacitor electrode 30 (fig. 1) over a semiconductor substrate 6 (fig. 1); forming a capacitor dielectric region 32 (fig. 1) onto the first capacitor electrode 30, the capacitor dielectric

Art Unit: 2814

region 32 comprising an exposed oxide containing surface (col. 4, lines 35-45); treating the exposed oxide containing surface of the capacitor dielectric region with at least one of a silane (col. 4, lines 35-40); and depositing a second capacitor electrode 32 (fig. 1) over the treated oxide containing surface, the second capacitor electrode 32 comprising an inner metal surface contacting against the treated oxide containing surface. Note that Merchant teaches that the dielectric layer is formed before the top electrode is laid thereon, thereby being exposed. Merchant teaches that the dielectric layer is made of silane oxide which is an inherent result of silane doping of the oxide material.

As to claim 2, the first capacitor electrode consists essentially of semiconductive material (col. 1, col. 39).

As to claim 3, the first capacitor electrode consists essentially of metal (col. 1, lines 39-40, and col. 4, lines 31-45).

As to claims 4 and 14, the exposed oxide-containing surface comprises hafnium oxide (col. 4, lines 40-41) and has a thickness.

As to claim 9, the treating is with at least one silane (col. 4, lines 39-41).

As to claim 10, Merchant is silent about halogen, thereby the silane is used during the treating is implicitly void of halogen.

As to claim 11, the compound formula for silane is SiH_4 which falls within the selected options of the claim.

As to claim 19, the inner metal surface comprises an elemental metal (col. 1, lines 39-41).

As to claims 12-13 and 97, the treated layer 32 (fig. 1) has a thickness.

As to claim 20, the inner metal surface comprises tungsten (col. 1, lines 39-41).

Art Unit: 2814

As to claim 21, the inner metal surface comprises a conductive metal compound (col. 1, lines 39-41).

As to claim 22, the inner metal surface comprises TiN (col. 1, lines 39-41).

As to claim 23, the second capacitor consists essentially of metal (col. 1, lines 39-41).

As to claim 24, the effect of treating has an inherent result as claimed.

As to claim 25, the silane oxide of Merchant has an OH groups that inherently result in the treating effect as claimed because silane compound formula is SiH_4 and the combination of silane and the oxide containing surface would inherently include an OH group as claimed.

As to claim 32, the first capacitor consists of semiconductor material (col. 1, lines 38-39) and the second capacitor consists essentially of metal (col. 1, lines 40-41) thereby being forming an MIS capacitor. Note that the dielectric layer is an insulator layer.

As to claim 33, the first capacitor electrode consists essentially of metal (col. 4, lines 30-34) and the second capacitor electrode (col. 4, lines 30-45) consists essentially of metal forming an MIM capacitor. Note that the dielectric layer is an insulator layer.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

Art Unit: 2814

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

11. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

12. Claims 5, 15, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Merchant, as applied to claim 1 above, in view of Emesh et al. (5,452,178) (hereinafter Emesh).

Merchant discloses the invention substantially as claimed. However, Merchant does not explicitly teach specifically that the oxide-containing surface comprises aluminum oxide.

Emesh discloses an analogous method and device capacitor having a first electrode and a second electrode with a dielectric layer 60, 64, 66 (fig. 3) made of aluminum oxide (col. 9, lines 26-27) and sandwiched in between the electrodes, wherein the dielectric layer includes multi-layers 60, 64, 66, 70 (fig. 3).

Therefore, as to claims 5, 36, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the invention of Merchant with aluminum oxide, as taught by Emesh, so as to provide an alternative material for the dielectric layer.

In claim 15, the dielectric layer has a thickness dimension.

Art Unit: 2814

13. Claims 6-8, 37-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Merchant, as applied to claim 1 above, in view of Kudoh et al. (6,853,540) (hereinafter Kudoh).

Merchant discloses the invention substantially as claimed. However, Merchant does not explicitly teach that the treating is with at least one borane.

Kudoh discloses an analogous method and capacitor having borane coupling agent (col. 3, lines 25-30) added to the surface of the insulating layer (dielectric layer) of the capacitor device.

Therefore, as to claims 6, 37, it would have been obvious to one of ordinary skill in the time the invention was made to modify the invention of Merchant with the borane agent added to the surface of the dielectric layer, as taught by Kudoh, so as to prevent electrical breakdown (Kudoh, col. 3, lines 35-39).

As to claims 7, 38, Kudoh teaches the use of borane without mentioning halogen which is interpreted as being void of halogen.

As to claims 8, 39, generally the compound formula for borane in Merchant is BH_3 .

14. Claims 16-18, 34-35, 40-50, and 98 are rejected under 35 U.S.C. 103(a) as being unpatentable over Merchant, as applied to claim 1 above, in view of Narwankar et al. (6,475,854) (hereinafter Narwankar).

Merchant discloses the invention substantially as claimed. However, Merchant does not explicitly teach that treating comprises a temperature range of 200-500 degree Celsius and a pressure range of 1-100 Torr.

Narwankar discloses an analogous method and capacitor having a first electrode, a second electrode, and a dielectric layer 606 (fig. 6f) sandwiched between the electrodes. The

Art Unit: 2814

dielectric layer 606 is treated or annealed at a temperature of 350-550 degrees Celsius and a pressure of few Torr (2.5 Torr to 1 atm. (Table 1, col. 12). The temperature range and the pressure range overlap the claimed ranges.

Therefore, as to claim 16, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the invention of Merchant with the temperature and pressure ranges, as taught by Narwankar, so as to provide the parameter value for the treating.

As to claims 17 and 18, 34, 44, Narwankar teaches that the treating is for 2 minutes (col. 12, Table 1) so as to provide the duration for annealing which falls within the at least 1 second, or at least 10 seconds as claimed.

As to claim 35, Merchant teaches that the exposed oxide-containing surface comprises hafnium oxide (col. 4, lines 40-41) and has a thickness.

As to claim 40, Merchant discloses the treating is with at least one silane (col. 4, lines 39-41).

As to claim 41, Merchant is silent about halogen, thereby the silane is used during the treating is implicitly void of halogen.

As to claim 42, generally the compound formula for silane in Merchant is SiH_4 which falls within the selected options of the claim.

As to claim 43, Merchant teaches that no layer of the electrodes is treated.

As to claim 45, Merchant teaches the inner metal surface comprises tungsten (col. 1, lines 39-41).

As to claim 46, Merchant teaches the inner metal surface comprises a conductive metal compound (col. 1, lines 39-41).

As to claim 47, Merchant teaches the inner metal surface comprises TiN (col. 1, lines 39-41).

As to claim 48, Merchant teaches the second capacitor consists essentially of metal (col. 1, lines 39-41).

As to claim 49, Merchant teaches the effect of treating has an inherent result as claimed.

As to claim 50, Merchant teaches the silane oxide of Merchant has an OH groups that inherently result in the treating effect as claimed because silane compound formula is SiH_4 and the combination of silane and the oxide containing surface would inherently include an OH group as claimed.

As to claim 98, Merchant teaches that the dielectric layer has a thickness dimension.

15. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Merchant, as applied to claim 1 above, in view of Nakamura et al. (6,605,530) (hereinafter Nakamura).

Merchant discloses the invention substantially as claimed. However, Merchant does not explicitly teach that the second electrode comprises a halogen containing gas. Note that the effect of treating with silane is the same as claimed.

Nakamura discloses an analogous method and capacitor having a first electrode 101, a dielectric layer 102, and a second electrode 103 (fig. 47), wherein the second electrode 103 comprises a halogen containing gas (col. 18, lines 14-15).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the invention of Merchant with the halogen containing gas, as taught by Nakamura, so as to provide the halogen-containing second electrode.

Art Unit: 2814

16. Claim 51 is rejected under 35 U.S.C. 103(a) as being unpatentable over Merchant, in view of Narwankar et al. (6,475,854) (hereinafter Narwankar), as applied to claim 34, and further in view of Nakamura.

Merchant, in view of Narwankar, discloses the invention substantially as claimed. However, Merchant, in view of Narwankar, does not explicitly teach that the second electrode comprises a halogen containing gas. Note that the effect of treating with silane is the same as claimed.

Nakamura discloses an analogous method and capacitor having a first electrode 101, a dielectric layer 102, and a second electrode 103 (fig. 47), wherein the second electrode 103 comprises a halogen containing gas (col. 18, lines 14-15).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the invention of Merchant, in view of Narwankar, with the halogen containing gas, as taught by Nakamura, so as to provide the halogen-containing second electrode.

Allowable Subject Matter

17. Claims 27-31 and 52-54 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

18. The following is a statement of reasons for the indication of allowable subject matter: The prior art of record does not disclose or fairly suggest either in singly or in combination a method of forming a capacitor having a step of depositing multiple dielectric layers and intermediate at least some of the dielectric layer depositions, treating an outer surface of the

Art Unit: 2814

dielectric region being formed with at least one of the borane or silane, and other steps in the claims.

Conclusion

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Vikki Trinh whose telephone number is (571) 272-1719. The Examiner can normally be reached from Monday-Friday, 9:00 AM - 5:30 PM Eastern Time. If attempts to reach the examiner by telephone are unsuccessful, the Examiner's supervisor, Mr. Wael Fahmy, can be reached at (571) 272-1705. The office fax number is 703-872-9306.

Any request for information regarding to the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Also, status information for published applications may be obtained from either Private PAIR or Public Pair. In addition, status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. If you have questions pertaining to the Private PAIR system, please contact the Electronic Business Center (EBC) at 866-217-9197 (toll free).

Lastly, paper copies of cited U.S. patents and U.S. patent application publications will cease to be mailed to applicants with Office actions as of June 2004. Paper copies of foreign patents and non-patent literature will continue to be included with office actions. These cited U.S. patents and patent application publications are available for download via the Office's PAIR. As an alternate source, all U.S. patents and patent application publications are available on the USPTO web site (www.uspto.gov), from the Office of Public Records and from commercial sources. Applicants are referred to the Electronic Business Center (EBC) at <http://www.uspto.gov/ebc/index.html> or 1-866-217-9197 for information on this policy. Requests

Art Unit: 2814

to restart a period for response due to a missing U.S. patent or patent application publications
will not be granted.

Vikki Trinh,
Patent Examiner
AU 2814

A handwritten signature in black ink, appearing to be 'VJ' or similar, written over the printed name 'Vikki Trinh'.